SCIENCE

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. ITHACA, N. Y., JUNE 28 TO JULY 3, 1906.

REPORT OF THE GENERAL SECRETARY.

THE fifty-sixth meeting of the American Association for the Advancement of Science was held at Ithaca, New York, June 28–July 3, 1906. This meeting was peculiar in being an extra meeting in the summer, the winter meeting at New Orleans having been held only six months before, and a winter meeting being planned for New York six months later. As a consequence of the fact that it was an extra meeting, there were no presidential addresses, no election of officers, except to fill vacancies, and there was but little action of any kind taken by the council.

The registered attendance of the association members was 232, and 94 members of the American Chemical Society were known to be present who were not registered as members of the association, making a clearly ascertained total attendance of 326. Other information, derived from the registration of four affiliated societies, indicates that the total attendance was about 400. As to attendance, the meeting was intermediate between the two meetings next preceding, namely, at New Orleans and at Philadelphia.

The following table shows the registered attendance by sections, and the affiliated societies which met at Ithaca:

Section A, 1. (No meeting of section was held.)

Section B, 50. American Physical Society.

Section C, 45. American Chemical Society and the New York Chapter of the Society for Chemical Industry.

Section D, 23. Society for the Promotion of Engineering Education.

Section E, 14.

Section F, 42. American Microscopical Society.

Section G, 30.

Section H, 6. (No meeting of the section was held.)

Section I, 14.

Section K, 3. (No meeting of the section was held.)

Four persons registered indicated no preference as to section.

Section B and the American Physical Society had a joint program of 29 papers, in which no distinction was made between the papers furnished by the two organizations, the papers being arranged according to topics.

Section C held no formal meeting. Its secretary aided the representatives of the American Chemical Society in preparing the program of their Ithaca meeting, and in making preparations for a joint meeting in New York. This society had a program of more than 80 papers, and its meetings were divided into sections.

The chemists constituted about one third of the total attendance at Ithaca. The chemists and physicists together constituted about one half of the total attendance.

It is interesting to note further that of the 231 members of the association registered, about one half, or 121 to be exact, are members of the affiliated societies meeting at this time and place.

The geographical distribution of the members in attendance can be computed only for the 231 registered members of the association; of these, 94 come from New York State; 20 from Massachusetts; 17 from Pennsylvania; 16 from the District of Columbia; 12 from Ohio; 10 from Illinois; 7 from Michigan; 5 from Indiana; 5 from New Jersey; 4 from Canada, Kentucky and California; 3 from New Hampshire, Minnesota, Missouri, Connecticut and Virginia; 2 from Iowa, Nebraska and Maryland; and 1 each from Tennessee, North Carolina, Alabama, South Carolina, Mississippi, Vermont, Rhode Island, Wisconsin and Kansas.

The meetings of Section D were held on Friday and Saturday. They were followed by those of the Society for the Promotion of Engineering Education in the same room on Monday and Tuesday, with an attendance about 50 per cent. greater than that of Section D.

Section E held two sessions on one day for the reading of papers, and devoted the remaining three days to excursions to points of interest from a geological point of view, near the northern end of Cayuga Lake, near the southern end of Cayuga Lake and at Enfield Glen.

Section F and the American Microscopical Society had a joint program.

Section G spent two and a half days in excursions to points of special interest from the botanical point of view, including a visit to Enfield Gorge. One day was spent in informal discussion of matters observed on the excursions. The Fern Chapter and the Society for Horticultural Science met at Ithaca just before the meeting of the association.

The attendance at the meetings of Section I was 25 to 40, considerably in excess of the registered number of members of that section (14). Nineteen papers were presented.

The relations between sections and affiliated societies were entirely harmonious in every case, the officers cooperating cordially in a common cause.

Cornell University placed its buildings at the disposal of the association, and each

day furnished a mid-day lunch to the members. An appropriate resolution of thanks was adopted.

The following general events added greatly to the meeting:

1. The informal smoker at the Town and Gown Club on Thursday evening.

2. The formal opening and dedication of Rockefeller Hall, the magnificent new Physical Laboratory of Cornell University, on Friday afternoon, with short addresses by President J. G. Schurman, Professor E. L. Nichols, Dr. Elihu Thomson, Dr. W. H. Welch (the president of the association) and a letter from Professor W. A. Anthony, read by Professor E. Merritt.

3. An address on Saturday evening by Professor Henry S. Carhart, of the University of Michigan, on 'The South African Meeting of the British Association for the Advancement of Science,' illustrated by a most excellent series of lantern slides.

4. A reception on Monday afternoon by Dr. and Mrs. Andrew D. White at their residence on East Avenue.

5. A public address on the recent California earthquake by Professor J. C. Branner, vice-president of Stanford University, given under the auspices of the local chapter of Sigma Xi in commemoration of the twentieth anniversary of the founding of the society. This was immediately followed by a Sigma Xi banquet, which was largely attended.

There were during the meeting, both within and outside of the council, various discussions of the relations of the association and of the affiliated societies. The only resolutions passed by the council bearing directly upon this matter follow:

Resolved, That the secretary of each section be required to prepare for the New York meeting a program of general interest for at least one session of his section.

Resolved, That the secretaries of the sections be requested to confer with each other, and with the secretaries of affiliated societies, regarding the relation of programs for the New York meeting, and

Further, That the sectional committees be empowered to turn over technical papers to the technical societies, and

On motion, the permanent secretary was instructed to prepare a list of members of the association who belong to the affiliated societies accepted as possessing proper qualifications, and to submit these names to the council at the New York meeting, with the recommendation that they be elected as fellows.

The social features of the meeting were unusually pleasant; and, although there was no central rallying point for all the scientific people in attendance, except the luncheon place at 1 o'clock, the opportunities for social converse were many.

The Ithaca meeting will be remembered by those who attended it as one of moderate size, thoroughly successful as to number and quality of papers presented, characterized throughout by harmonious relations, especially notable for pleasant and profitable excursions, and given a tone of peculiar charm by scenic surroundings unrivaled by those of any other college campus in the United States.

The addresses made at the opening general session in Barnes Hall on Friday, June 28, are appended to this report.

JOHN F. HAYFORD,
General Secretary.

The first general session of the association was held in Barnes Hall, Cornell University, at 10 o'clock on Friday morning, June 29, 1906. The president of the association, Dr. William H. Welch, after calling the meeting to order, introduced Dr. J. G. Schurman, president of Cornell University, who delivered the following address of welcome:

Ladies and Gentlemen: I have very

much pleasure, on behalf of the university under whose auspices you meet, to extend a cordial welcome to the members of the American Association for the Advancement of Science, to the affiliated societies and to the friends who accompany them here. We feel it a great honor to have under our roof so large a gathering of distinguished scientists from all parts of the country.

I notice that you have timed your meetings so that you may be home by the Fourth of July to properly celebrate that day. I was thinking that if you practised on this occasion the scientific habit of analysis, and asked yourselves what was especially worthy of celebration in the day, you would perhaps sum it up under two or three heads. One of them undoubtedly would be the fact of a great nation of freemen governing themselves. The second, I think, would be the splendid mechanisms for the production and transportation of economic commodities which this republic has developed since the first Declaration of Independence. And I think the third would be the unusually high level of material comfort which the great majority of our population enjoy. You see I have made a close connection between the third of July and the fourth. If I am right in the analysis I have made, and have described correctly the three most important things that this republic has to celebrate as each fourth of July returns, we can recognize that two of them, at least, are the results of the labors of scientists. We can not, perhaps, attribute to scientists a larger share than we attribute to other citizens in the bringing out and maintaining of a free government, but if we have our splendid system of economic production, and if the tide of material comfort runs higher here than anywhere else on the globe, it is due, first of all, to the abundant resources of our country, and secondly to the discoveries and investigations for which scientific men are responsible. And when I say that scientific men have in this way helped to produce two out of the three most important things which characterize our own republic, I do not feel that I have exhausted their highest work, for science has during the last hundred years revolutionized the civilization of the world. It has in other countries, as in our own, increased material comforts, multiplied inventions and extended knowledge. It has introduced new modes of thought and new standards of evidence. The civilization of the earlier centuries was colored and molded by hearsay and tradition, whereas one of the most splendid achievements that has come to our age through the advance of science is the resting of knowledge on evidence, and on theory and hypothesis only as they are maintained by it. No one who has studied the thought and considered the progress of the world in its highest spiritual aspects can feel that I have stated the fact too strongly in saying that science has revolutionized the civilization of the past—first of all, that of Europe and of America, and later that of Asia also.

So, ladies and gentlemen, we at Cornell University feel it a great honor to have in our midst for a number of days the representatives of those men and women who by the achievements of their labors and intellects are really shaping the advance of nations and molding the civilization of mankind. I am not certain that we can adequately show you the honor which we feel. We labor under a certain disadvantage, for it is now vacation and many members of our faculty have left their homes, but what it was in our power to do we have done. We have placed the facilities of the university here freely at your disposal. Ithaca is not as well provided with hotels as some of the larger cities, and so to supplement our local resources in that regard we have opened Sage College, and the graduates and undergraduates who control

fraternity houses have also thrown them open. Our members will be ready, as the announcement explains, to take excursions to different parts of the surrounding country. We believe that we have here the most beautiful and most romantic college or university campus in the world. What lies in our power we are anxious to do. Our trustees have arranged for a luncheon to be served to you daily in the University Armory during your stay. I hope, Mr. President, you will not expect too much of us. We have done the most we could in the way of entertainment, and we hope you will accept the will for the larger deed which might have been possible in Washington, Baltimore or New York.

Ladies and gentlemen, once more I express the great pleasure we feel in having you with us, and in the name and on behalf of Cornell University I put what we have at your free disposal.

President Welch then introduced the Hon. Bradford Almy, mayor of Ithaca, who welcomed the association to the city in the following address:

Mr. President, and Ladies and Gentlemen: The people of this city rightfully feel that this is an important event with them. They feel that Cornell University, the institution in which they take so much pride, is the cause of their having the pleasure of your visit to our city at this time. That an organization so eminently distinguished as the American Association for the Advancement of Science, composed of individual leaders in thought, labor and achievement along all the lines that lead to the progress, welfare and happiness of our people, should assemble in Ithaca for their deliberations is a compliment which we sincerely appreciate and for which we are very glad.

The profound sense of gratitude which we all feel for the heroes, self-sacrificing in their labors as pioneers of science, who caused a ray of light to shine here and there in the utter darkness, may perhaps be a measure of the feelings which we have for you men and you women who are laboring along lines of work so persistently followed and so diligently wrought out for the benefit of mankind and the civilization of the world. We can all remember, for it was not so very long ago, when science and religion were believed to be at war with each other. That thought delayed its progress for a time, but science has made great advance during the years since that idea has left the minds of men. Happily, those times are past, and to-day science is regarded as more than the handmaid of religion. In bidding you the hearty welcome to our little city, which I have the honor and pleasure of extending to you on behalf of our people, I bid you Godspeed in the noblest work that can engage the thoughts and energies of mankind. At the same time, while we are conscious that the advancement in the last fifty years has been so great and so strengthens the courage and inspires the zeal for future work, we realize how diminutive are the regions of the known compared with the vast, untrodden wilderness on the border land of which you stand.

In closing, let me express the wish that you may have as prosperous a congress here as you have expected, that you may enjoy your visit as much as we hope you will and that you may go away with pleasant recollections of us and of Ithaca.

President Welch made response to the addresses of welcome, as follows:

Ladies and Gentlemen: In behalf of the members of the association, of our guests and all here present, I wish to express to you, President Schurman and Mayor Almy, our very cordial appreciation of the words of welcome which you have given us. This is the first meeting of the association in Ithaca. It is also a renewal of an old

custom of holding a midsummer meeting, and I do not know where that renewal, somewhat experimental, of the old custom could be inaugurated under more favorable conditions than in this place. Where could this association feel more at home than here at this home of learning and of science? It must, I think, be a satisfaction to the members at Cornell University to be enabled to show to their fellow members in this association the splendid opportunities which exist and the evidences of the great work done here, and it is equally a pleasure and source of profit to us to enjoy this privilege. We know that this is one of the great and leading universities of the country; that when it was founded Cornell University was enabled to do a work that was highly distinctive and significant and which marked a great advance in higher education in America, and that this position of leadership it has never lost. It is a great delight to come at this time of the year to this charming town and enjoy the wonderful beauties of nature in this region. They appeal not only to lovers of science, but to lovers of nature as well, and it would seem that the study of natural history must be stimulated by such surroundings as exist here. So, I say, we are particularly fortunate in coming to Ithaca and to Cornell University at this time.

The American Association for the Advancement of Science has had a very useful and honorable history. At the time it was founded and for many years afterward it was possible for a single association to represent in a very definite and concrete way all the existing natural and physical science in this country. During this period the scientific activities of the country were represented more adequately and comprehensively in this association than in any other body. But as time went on, science in its various branches extended and grew, conditions changed, and it became evident that it was necessary for the association to adjust itself to those new conditions, the main one being the specialization of scientific work. That specialization has been a great instrumentality in the progress of science throughout the world, but nevertheless it has certain disadvantages and even dangers of its own. I believe that the highest function of this association is to try to minimize to the greatest possible extent the dangers that may arise from the minute subdivision of scientific research. As its name implies, this association represents a central body for the advancement, and, it may be added, the diffusion and the organization of science in America. It may be at times a little burdensome for active workers in one department of science to feel interested in the central organization, but I conceive it to be their highest duty to do so. They should consider the interests of science as a whole in this country, as well as those of their particular branch of science, for unless the whole tree of science flourishes the branches will suffer.

This association represents, as it were, an association of various special scientific societies, perhaps more than an association of various scientific workers. It is necessary to have this coordination of societies in order to bring together the great body of scientific workers throughout the country, but in the plan of our organization the affiliated societies in no sense lose their autonomy and it is essential that they should not. The centers of scientific activity in this country are not concentrated in a few points, as in most European countries, and it is believed that this plan of organization best meets the special conditions of science in America.

It is very important, under our form of government, that there should be a central authoritative voice which speaks for science. How many questions there are, as has been suggested by President Schurman,

relating to the highest welfare of society which can be solved only by science, and how important it is that workers in kindred subjects should be brought into contact with each other! There are matters of education, matters of public policy and matters of research in all departments of the government and of national life that sustain very close relations to the opinions of scientific men, and it is, therefore, of first importance that there should be a body which can express in an authoritative and representative way the scientific opinion of the country.

This experiment of renewing the midsummer meeting indicates in a measure the great growth in membership and in influence of this association. In so doing, of course there is no intention of abandoning the meetings in the winter. It was necessary, in bringing about a proper adjustment of the work and aims of the association to the specialization of science as represented in the various affiliated societies, to adopt the plan of a winter meeting, but the association while gaining much undoubtedly lost something by it. Certain members, desirable to have with us, were unable to attend, and the more popular side of the work may have suffered somewhat because of the more special and technical character of the papers presented at the meetings in the winter. There are many, such as school teachers, amateurs and others intelligently interested in natural and physical science, but not actively engaged in research, whose support and interest it is desirable that the association should secure and who formerly attended the summer meetings. It is to be hoped that this effort to renew that kind of work and influence of the association which was expressed in the old days by the midsummer meeting will be successful and this extension of influence can be secured without any impairment of strictly scientific aims. As I have said, we certainly could not inaugurate the movement under better conditions than at this time and in this place.

This is the first opportunity that I have had to appear in my official capacity before the association, and I wish to express my appreciation of the distinguished honor which was conferred on me at the meeting in New Orleans. The honor is not merely a personal one, but I interpret it as a recognition of medical science as an integral, coordinate part of the natural science of this country; and medical science, in my judgment, fully merits this recognition on account of the paths which it has opened up and followed and the great advance which it has made in recent years.

President Schurman has indicated to us the intimate relations which science sustains to the highest interests of society throughout the world, and this condition has been brought about largely through scientific discoveries and their application to useful purposes. It is the glory of medicine that in these later days it has been able to contribute its share, a share not unworthy of its rank among the sciences of man and of nature, toward the advancement of useful knowledge. It has done so partly by recognizing the fact that a large part of medical science is essentially biological science, and that this is not only true of normal anatomy and physiology, but that pathology, the science of disordered structure and function, may be considered and cultivated to a large extent as biological science. This has been one of the reasons for the great advance in medicine. The scientific method, the method of observation, experiment and reasoning, in contrast with the dogmatism, speculation and reliance on authority which for centuries dominated the history of medicine, is recognized to-day by medicine as fully as by any science as the only source of fruitful progress.

But above all, it has been discoveries resulting from the opening up of new paths of investigation which have impressed both the scientific and the popular mind with the importance of medical science. In the last three decades medicine has advanced to a position where it stands as never before in the very closest relations to the highest interests of human society. When you consider the vast accumulations of population in cities, the great industrial activities of modern times, the efforts to colonize and to reclaim for civilization tropical countries and waste lands, such a stupendous undertaking as the digging of the Panama Canal, all dependent in a very direct manner upon our power to control the spread of epidemic and endemic diseases, and that this power has come from the discovery of parasitic microorganisms and the study of their properties and of the manner of propagation of agents of infection, it must be clear to you that medicine, especially preventive medicine, is most intimately related to the progress of civilization and the advancement of human society. So the time has fully come for medical science to stand side by side with other sciences and to be represented with them in this association.

I was expected on this occasion not to make a formal address but simply to reply to the cordial words of welcome which have been extended to us on behalf of the university and of the city. The evil day, fortunately for you and for me, seems by the plan of organization to be put far off, when the incoming president is expected to make his formal address to the association.

I now have pleasure in declaring this fifty-sixth session of the American Association for the Advancement of Science open, and I trust that the sessions of the association and the meetings of the several sections and affiliated societies will be full of interest and profit to all in attendance.

After announcements by the general, permanent and local secretaries, the general session of the association was adjourned.

JAMES MILLS PEIRCE.

One summer morning nearly forty years ago the boys who were to take their examinations for admission to Harvard College were assembling in Harvard Hall to meet the officer in charge of the examinations, Professor James Mills Peirce. As the room filled he walked slowly up and down the platform, his hands clasped behind his back in a manner very familiar to all his friends, looking now at the boys, now out of a window, but saying not a word. One of the boys, now himself a professor in the university, leaning over, whispered in Greek to his friend an adapted line of Homer—'Behold him as he walks, the shortest of them all, but kingliest of men.' Such was the impression made then and always by James Peirce on those who were fortunate enough to meet and know him. It is the purpose of the following sketch to give some account of his life together with a short description of the changes which, during his fifty years of service, took place in Harvard University.

James Mills Peirce was born in Cambridge on May 1, 1834. He was the son of Benjamin Peirce, the great mathematician, and Sarah Mills Peirce. The father of Benjamin Peirce, also named Benjamin, was librarian and the first historian of Harvard College. James Peirce's maternal grandfather was a representative in congress, later senator from Massachusetts, and a colleague of Daniel Webster. James Peirce graduated from Harvard College in 1853. The next year he spent at the Law School. In 1854 he gave up the study of law to become a tutor in mathematics in Harvard College. In 1857 he entered the Divinity School, retaining his position as

tutor, however, until 1858. After graduating in 1859 from the Divinity School, he spent the next two years preaching in the Unitarian churches in New Bedford, Mass., and in Charleston, S. C. In 1861 he gave up the ministry to return to Harvard as assistant professor of mathematics, and remained in the service of the university until his death. In 1869 he was made professor of mathematics, and in 1885 appointed to the Perkins professorship of mathematics and astronomy. He served as secretary of the Academic Council from its establishment in 1872 until 1889, as dean of the graduate school from its foundation in 1890 until 1895, and as dean of the faculty of arts and sciences from 1895 until 1898. His resignation from the faculty, to take effect in March, 1907, on the completion of fifty years' service as a teacher in the university, was accepted by the president and fellows only a few weeks before his death. He died suddenly of pneumonia on March 21, 1906, in the seventy-second year of his life and in the fiftieth year of his service as a teacher in the university. It is a curious coincidence that his father also died in the seventy-second year of his life and in the fiftieth of his service in the university.

The period from 1860 to 1880 was a time of great changes in the university, the development of the elective system, and the beginning of the graduate school. With these changes James Peirce had much to do. It may justly be said that the great work of his life was the development of graduate instruction in Harvard University. Accordingly I purpose to give some account of the condition of the mathematical instruction at Harvard at the beginning of his academic career, and to show by following its development the growth of the elective system, the beginning of graduate instruction, and to trace, as far as possible, his influence in this period of transition.

In 1853 when he graduated from college the mathematical instruction was given by his father, Professor Benjamin Peirce, and by a single tutor, Mr. C. F. Choate. The course consisted of required freshman work in plane and solid geometry, algebra and plane trigonometry; of required sophomore work in algebra, spherical trigonometry and analytic geometry; of elective courses for juniors and seniors in 'imaginary, integral and residual calculus,' in mechanics, and in astronomy. All college work in the freshman and sophomore years, and in the junior and senior years three fifths of the work, was required. The elective system, though undeveloped, had already had its beginning. About 1849 this small privilege of election was in danger of being withdrawn by the faculty; at one time a majority of this body actually favored making the whole course required. The elective system was saved at that time by the determined fight of a few liberal-minded men, prominent among whom was Benjamin Peirce.

In 1854 Tutor Choate resigned and in his place James Peirce was appointed. In the same year his classmate, Charles W. Eliot, was also appointed tutor in mathematics, the teaching force of the department being thus increased to three. The tutors hereafter carried on the freshman and sophomore work, leaving Professor Benjamin Peirce free for more advanced work. James Peirce, having the first appointment, had the choice between freshman and sophomore work. With a modesty which always characterized him, he decided to teach the freshmen, believing himself not so well qualified to give the sophomore instruction as to teach the more elementary freshman subjects.

At this time examinations in all college

courses were conducted orally by the instructors acting with examining committees appointed by the overseers. These examinations, far from being severe, were in some cases almost farcical. Some professors held rehearsals of the examinations prior to the visits of the overseers' committees; others gave the examinations in such a manner that a student might without difficulty discover just what question would be asked him, and prepare himself accordingly. Furthermore, the time for examining a student on one subject could not be extended beyond two or three minutes. It may be imagined that the passing of examinations was not a difficult matter. Indeed, it was not necessary for a student to pass even these examinations. For the faculty could not be prevailed upon to refuse its degree to a student, however bad his scholarship, if his conduct during his residence at the university had not incurred serious censure. It happened once in the early fifties that the faculty was almost persuaded not to vote a degree to a student of greater than usual incapacity, when it was discovered that the candidate had not once during his four years absented himself from prayers. The degree was granted without further debate.

Tutors Peirce and Eliot, dissatisfied with these oral examinations, introduced, during their first year, occasional written hour examinations in place of the regular recitations. These examinations were used by the instructors in making their reports, but did not replace the annual oral examination held in the presence of the overseer's committees. Other instructors, notably the teachers of the classics, followed the lead of the mathematical department. This new system of examination, requiring real knowledge on the part of the student, proved disastrous to the lazy and incompetent, and though bad reports of a student's scholarship did not at first prevent his obtaining a degree, the results soon made evident the impracticability of requiring every man to do the same work. There was resistance on the part of both faculty and overseers to the introduction of written examinations, and a still greater resistance to the abandonment of a system of required studies. But before very long even the most conservative members of the faculty were forced to admit that the real examination must be a written one. At a conference held by committees of the faculty and overseers were passed five resolutions concerning examinations, which were unanimously adopted by the faculty on March 9, 1857. Of these resolutions the most important were the following:

1. Examinations in all courses shall be annual and in writing.

2. All marking shall be done by the instructors.

3. All examinations shall be prepared and printed by the instructors, and shall be submitted to the several (overseers') committees previous to the examinations.

The introduction of written examinations was largely due to James Peirce and Charles W. Eliot. It made apparent the necessity of giving students a greater field of choice in their studies, but it did not by any means bring with it the modern elective system. For the next ten years, almost to the time when Mr. Eliot became president of the university, there was in the faculty a struggle between the advocates and the opponents of the elective system. The faculty at that time consisted of about fifteen members. The younger members and one or two of the elder ones were in favor of giving the college the elective system. But not till 1868 was any change made in the required mathematics for freshman and sophomores. For the first time in the academic year 1868–69 sopho-

mores were not required to study mathematics. Under the administration of President Eliot the elective system developed rapidly, but no further change in the mathematical requirement appears until 1884, when the freshman requirement was dropped. From the autumn of that year the study of mathematics in Harvard College has been wholly elective. Just what part James Peirce played in the development of the elective system is uncertain. He was active always for the freeing of students from restrictions, and for any movement which seemed to him likely to promote true scholarship. He was an advocate of the elective system, and was always, in the faculty, a staunch supporter of every step in the direction of greater liberty to the student.

He was absent from Cambridge from 1859 to 1861. In 1861 he returned to the university as assistant professor of mathematics. In the previous year Mr. Eliot had been made assistant professor of mathematics, but in this year he was called to take charge of the work of the scientific school. The mathematical teachers in Harvard College were then Professor Benjamin Peirce, James Peirce and a single tutor, Solomon Lincoln. In the courses of instruction offered in that year the only change from the list of 1853 is the addition of an elective in quaternions, given by the elder Peirce.

In 1863, at the request of a number of professors, the corporation ordered that—

> The president, with the (full) professors in all departments of the university, be authorized to meet and associate themselves in one body for the consideration of its educational interests, and for the arrangement of such courses of lectures as may be thought expedient for the benefit of the members of the professional schools, graduates of this or other colleges, teachers of the public schools of the commonwealth, and other persons.

This body was known as the university senate. The establishment of the senate laid the foundation of the graduate school, in the development of which James Peirce, though not a member of the senate, played a prominent part. This body instituted various courses of 'university lectures,' including, in the words of James Peirce, 'many of high value and interest in all departments of learning.' These courses were generally short, consisting each of not more than five or six lectures. In 1863–4, the first year of the lectures, three courses were given on mathematical subjects: 'The Theory of Space developed by Quaternions' and 'The Connection of the Physical and Mathematical Sciences,' by Benjamin Peirce, and 'Special Investigations in Dynamics,' by William Watson. In the following year these courses were repeated with the addition of a fourth on 'Determinants' by James Oliver. Apparently the courses in mathematics did not meet with a very cordial reception, for in the third year only one mathematical course was offered, 'The Development of the Universe,' by Benjamin Peirce. Indeed, it may be supposed that this course was philosophical as much as mathematical. In 1866–7 this course was repeated, and Thomas Hill, the president of the university, gave courses on 'Methods of Teaching Elementary Mathematics,' and on 'A Constant Product.' In 1867–8 Benjamin Peirce gave for the first time a course of university lectures on 'Linear Calculus.' It is probable that this course dealt with the linear associative algebras invented and developed by him. In that year James Oliver gave a course on 'Geometry of Three Dimensions.' In the following year there were no courses of university lectures in mathematics, but in the catalogue of the scientific school, which was at that time an institution especially intended for advanced study and research, is printed this note: 'Private instruction in the various branches

of mathematics will be given to those desirous of receiving it by competent instructors residing at the university.' These instructors were Professor Benjamin and James Peirce.

In the autumn of 1869 Charles W. Eliot became president of the university, and at once occupied himself with the development of the advanced instruction. Various short courses in related subjects were combined; many new and longer courses were offered. To quote again the words of James Peirce, 'a settled purpose was manifested to establish the instruction of advanced special students on a permanent and efficient footing.' In addition to certain university lectures there were offered that year two 'university courses of instruction,' one in philosophy and one in modern literature, each consisting of three lectures a week throughout the year, and each given by several instructors. The university lectures in mathematics were 'Linear Algebra,' thirty-five lectures by Benjamin Peirce; 'Algebraic, Periodic and Double Periodic Functions,' thirty-five lectures, and 'Higher Geometry,' eighteen lectures by James Peirce. This was the first year in which James Peirce gave university lectures. It was, too, the first time that any branch of the theory of functions was taught at Harvard. In this year the regular elective courses in mathematics were greatly increased in number, and James Peirce was then and thereafter entirely freed from giving freshman instruction. He taught that year four elective courses, each of two hours a week, on analytic geometry, differential calculus, integral calculus and elementary mechanics. Four electives were offered also by his father, consisting each of from one to three lectures a week, on mechanics, astronomy, quaternions and linear algebra.

During the next ten years there were no important changes made in the regular courses offered in mathematics. Benjamin Peirce, who was in 1869 sixty years of age, withdrew somewhat from active academic work, giving after 1870 not more than two courses a year, those generally on 'Quaternions, Mechanics and Linear Algebras.' The teaching of the elective courses was taken over almost wholly by James Peirce. He gave a great variety of courses, usually giving about twelve lectures a week. In 1870–1 he gave for the first time a regular course on 'The Theory of Functions,' in 1874–5 a course on 'Elliptic Functions,' in 1876–7 a course on the 'Functions of a Complex Variable,' following Briot and Bouquet. In 1878–9 he gave for the first time an elementary course on quaternions, his father giving the second course. In the following year James Peirce gave the advanced course, his father giving the first course. This plan of giving courses of two years on one subject, with two instructors alternating, has since that time been often followed at Harvard.

In 1870–1 the mathematical university lectures consisted of two courses, one on 'Celestial Mechanics,' two lectures a week for half the year by Benjamin Peirce, and a course of the same length on 'Modern Methods in Geometry' by James Peirce. The latter course has now become a fixture in the elective courses given every year, and, under the name of mathematics 3, is known to almost all students of mathematics who have been at Harvard during the last thirty years. In this year the number of courses of university lectures offered was thirty-three. The number of persons recorded in the catalogue as attending them is twenty-six.

Whether or not on account of the small attendance, it was found that the university lecture system was not satisfactory, and in 1872 these lectures were abandoned.

The university senate was reorganized as the academic council. The new body consisted of all professors, assistant professors and adjunct professors in all departments of the university. The degrees of Ph.D. and S.D. were instituted. The principal functions of the academic council were the administration of these degrees and the degree of A.M., and the superintendence of the advanced instruction. James Peirce was elected secretary of the council at the first meeting and continued to hold this position until 1889, when the chief functions of the body were transferred to the administrative board of the graduate school. In this capacity he practically had charge of the graduate instruction. He was behind every movement for giving the student greater privileges, as he was in favor of every change calculated to improve the quality or to raise the standard of instruction. In 1873–4 there were at the university forty candidates for the higher degrees. In 1894–5, the last year of his official connection with the graduate school, there were 255 resident graduate students, and 17 non-resident graduate students. The courses intended for advanced students were after 1872 regular elective courses and appear in the catalogue with the other electives. In the catalogue for 1875–6 appears for the first time a separate list of courses, twenty-five in number, intended especially for graduate students. In 1894–5 there were given 77½ courses intended primarily for graduates, 101½ intended for graduates and undergraduates. The development of the graduate instruction from 1872 to 1895 was steady but marked by no striking change. Of interest in this connection are the closing words of the last report made to the president of the university by James Peirce as dean of the graduate school. He writes in 1895:

I account it a high privilege that I have held the position of executive officer of our graduate department since it was first established in January, 1872. I have seen it struggle for years against the coldness and scepticism of many members of our own faculty and against untoward conditions in its constitution and in outward circumstances; and I now have the happiness of beholding it the acknowledged representative of the best culture, the most advanced science and the highest liberal learning of the university. I am fully conscious that I can claim nothing for myself in this progress, beyond a faithful service and an earnest endeavor to rivet attention to the highest ideals of intellectual work as furnishing the only true basis of the development of such a school. The graduate school is a genuine outgrowth of the demands of a generation of students now coming forward in America; and it is destined within a few years, as I confidently believe, to an expansion which will make its present prosperity look small. To this university it is already rapidly becoming the much needed regenerator of the motives and principles of student life; the open door which is admitting to us a national constituency; the western window letting in a flood of warmth and light to dissolve academic selfishness and narrowness, and to quicken us in the discharge of our highest duty, that of devotion to the service of our country and our time. When its own relations to the college proper have been satisfactorily established, through a wise readjustment of the grounds of our several degrees, it will gather into one bright focus the influence and authority of the scholarship of this university, and will carry on the name of Harvard to be still a conspicuous symbol of light and power to the coming century, as it has been to that which is nearing its close.

From the time of his father's death, in 1880, James Peirce was at the head of the mathematical instruction of the university. At the beginning of his service the teaching force was composed of one professor and two tutors; at the time of his death there were in the department of mathematics five professors, one assistant professor and two instructors. In 1854 the instruction offered embraced the required elementary freshman and sophomore work, and three elective courses. In 1905–6

there were offered five and a half courses primarily for undergraduates, of which two are of as advanced a nature as the electives offered in 1854; six courses intended for graduates and undergraduates; seven and a half courses of lectures primarily for graduates, and six courses of reading and research; in addition many other courses are named and described in the catalogue which are to be given in following years. As chairman of his department James Peirce was a most liberal-minded and conscientious administrator. He favored always the introduction of new courses, he was always desirous that the younger teachers should have an opportunity to give advanced instruction, he was scrupulously careful and painstaking in the details of administrative work. He seldom tried to impress his own opinion on the department, but preferred to be guided by the wish of the majority.

He gave himself a great variety of courses. Although his chief interest lay along the lines followed by his father, quaternions and other linear associative algebras, he was also much interested in geometry and in mechanics. In 1904–5 he returned to the teaching of mechanics after having laid the subject aside for many years. The course in which he is best known to the present generation of students are the two courses on 'Quaternions,' mathematics 6 and 9, and courses on 'Algebraic Curves and Surfaces,' mathematics 7*a*, 7*b* and 7*c*. These courses were well attended, especially those on 'Quaternions,' the number of students in mathematics 6 ranging from ten to twenty-five. He gave usually a course or two half courses each year, to a small number of students, on 'Linear Associative Algebras' or on the 'Algebra of Logic.' He never fell into the narrowing habit of giving year after year the same courses, but was eager always to undertake the teaching of some new branch of mathematics. In the last year of his life he gave a new half-course, an 'Introduction to Higher Plane Curves,' to serve as a preparation for his other courses on that topic. Indeed, so anxious was he to avoid falling into a rut that he made very slight notes for his lectures, preferring, in repeating a course, to work it out anew. This method resulted in a continual freshness and variety of presentation in his teaching. His courses were conducted by lectures, but his students had always opportunity for questions and discussion. His lectures were extremely clear and excellent in form. He loved to develop a subject with great generality without, however, sacrificing detail. In his courses he covered the ground slowly, and a younger generation of students have occasionally felt some impatience with his very careful and methodical discussions. He was not a great believer in the 'problem method' of teaching and he gave almost no home-work to his students. He was a mathematician of wide and varied learning. His life was given to his teaching, and to administrative work, rather than to research. He published little. In 1857, at the age of twenty-three, he published an 'Analytic Geometry,' based on a part of his father's famous work called 'Curves and Functions.' This 'Analytic Geometry' was used for many years as a text-book at Harvard, and was considered an admirable treatise. Of it Joseph Henry Allen, writing in the Harvard Register in 1881, says: 'I call (it) the very best text-book I ever used, and I never cease to bewail (that it) has gone out of print if not out of use.' This book, of 228 pages, contains a development of the elements of the subject with the usual applications to the study of conic sections. Written in a very attractive style, it is much more interesting reading, though it

would, perhaps, not be so useful in the class-room, than the modern text-book. It contains some explanation of the applications of conic sections to physical problems, and some sections which are in the author's own words 'speculative.' In 1873 he published a book of 83 pages on 'The Elements of Logarithms'; in 1888 a pamphlet of 67 pages called 'An Outline of the Elements of Analytic Geometry.' This is something more than a syllabus; it is rather a summary of the principles of the subject with short explanations. He published several books of mathematical tables, of which the last, 'Mathematical Tables Chiefly to Four Figures,' was published in 1879. These tables are well arranged and are widely used. He wrote few articles for scientific periodicals, the last one being 'On Certain Systems of Quaternion Expressions and on the Removal of Metric Limitations from the Calculus of Quaternions,' printed in the *Transactions of the American Mathematical Society* for October, 1904. He was the author of a few other short articles, one of which is 'A Rule Relating to the Calendar,' which appeared in the *Harvard Register* in 1881. He edited in 1881 a course of Lowell lectures given in 1877–8 by his father, to which he added certain appendices. In the course of his administrative work he wrote, as dean of the graduate school and as dean of the faculty, numerous reports to the president of the university, remarkable for their clearness and even more so for the richness and dignity of his style.

Professor Peirce was interested always in the social side of mathematics. When he began to teach at Harvard there was a mathematical club which held weekly meetings during the term in the lecture room of Professor Benjamin Peirce in University Hall. The club was small and not confined to members of the university. At the meetings James Peirce sometimes spoke. In later years a 'Mathematical Conference,' established by the department, has held fortnightly or monthly meetings, at which papers were presented by the students and, less often, by members of the teaching force. James Peirce was usually present at these meetings, attending them probably oftener than any other member of the faculty. Once or twice he presented papers, among the last, one of great interest on the history of mathematical teaching in Harvard University. Two years ago these conferences were discontinued, and were replaced by a mathematical club to which belonged both the teachers and the students of mathematics. In this club, too, Professor Peirce took the greatest interest, and at its first meeting read a paper on 'The Analytic Geometry of Descartes.'

In 1881 was founded by the teachers of mathematics and physics of Harvard and of the Massachusetts Institute of Technology a club known as the M. P. Club, the purpose of which was to bring together the teachers and advanced students of these subjects at both institutions as well as other people interested, to hear and discuss short papers, and to provide pleasant social intercourse. James Peirce was elected its president, and continued to serve in this office until his death. He gave the club much thought and time, and took a deep interest in its welfare. One meeting each year was usually held at his house and that meeting was generally the pleasantest of the year. Of late years he felt that he had served too long as the club's president, and on several occasions offered his resignation, but in his own phrase, he always returned to his home 'unresigned.' He was a very regular attendant and a most modest and charming presiding officer. The first subject discussed by this club was 'Can there be a discontinuous

function?' It was voted after debate that no discontinuous function exists.

At the time of his last illness plans had already been made for an anniversary dinner of the club, at which a loving cup was to have been presented to him as a token of the appreciation, felt by the members, of his quarter century of service as president.

No man could have been more closely identified with Harvard University than was James Mills Peirce. Born and educated in Cambridge, he spent there nearly every winter of his life. From the time of his entrance into Harvard College as a freshman in 1849 until the death of his father in 1880 he lived in the college yard as student, tutor and professor.

He was a man of most sweet and friendly disposition, kind to all with whom he came in contact, slow to anger, aroused only by injustice; a man of wide acquaintance and of many friends, most hospitable in his own home, fond of society and given to sociability. A lover of music and widely read in English literature, he was a man of the broadest intellectual interests.

What marked him most was a great faithfulness. He never faltered in his work, he never lost interest, indeed his enthusiasm grew greater from year to year. The welfare and the usefulness of the university were his dearest concern, and for their advancement was given the whole of a long and active life. He died, as we must suppose he would have chosen to die, working to the end.

J. K. Whittemore.

Harvard University.

DISCUSSION AND CORRESPONDENCE.

NORTHERN LIMIT OF THE PAPAW TREE.

Some years ago I was surprised to receive from a correspondent, Mr. Kennyon, of McGregor, Ia., a specimen of the papaw tree found native in the vicinity of McGregor. Below McGregor on the Mississippi, between Dubuque and Specht's Ferry, quite a number of specimens of this plant were observed. Some years later, while botanizing in the vicinity of Clinton, Ia., the species was found in flower. I have never seen any fruit at any point near here, but feel warranted in saying that the plants are perfectly hardy and do bear fruit. In all of these cases the plants were found growing on the sides of limestone hills. It may be of interest also to note in this connection that the pecan also occurs on the Mississippi at Savannah, Ill., which is somewhat north of the latitude usually given for it. While it is true that the Indian may have been an agent in the dissemination of the seed of the papaw, it was probably also disseminated in other ways.

L. H. Pammel.

THE CRAYFISH INDUSTRY.

In my recent article on 'The Future of the Crayfish Industry,' in Science, June 29, two errors appear on page 984. The value \$420 in line fourteen should be \$4,200 and the amount of 165,000 in line twenty-two should be 116,400, as *correctly* stated in the statistics of the Bureau of Fisheries.

E. A. Andrews.

SPECIAL ARTICLES.

EMISSION OF ELECTRICITY FROM THE RADIUM PRODUCTS.[1]

Hitherto, the rate of decay of the induced activity produced by radium, has not been studied by means of the charge carried away from the active body by the α and β rays.

The following is a brief report of the results of two series of experiments on the charge of electricity carried by these rays.

In the first series of experiments, a metal wire was made active by immersion in radium emanation; and immediately after removal from the emanation vessel, was placed inside a small hard rubber tube, with very thin walls. The outside of the tube was surrounded by

[1] An abstract of a paper read before a meeting of scientists, at the University of Colorado, on May 5, 1906.

mercury connected metallically to the earth; and the wire on the inside of the tube was connected to a quadrant electrometer. Under these conditions, positive electricity was discharged from the wire, for five or six minutes, and the electrometer indicated the accumulation of a negative charge. After the expiration of ten minutes, the electrometer indicated the accumulation of a positive charge, and the emission from the wire of negative electricity. This is in accord with the accepted views as to the charges carried by the α and β rays. Radium A radiates α rays only, and radium C, both α and β rays. Further, radium A disappears in ten minutes, so that the α rays, coming from radium A and radium C, passing through the rubber, caused a negative charge to appear on the wire for the first few minutes. After ten minutes radium A disappeared, and the positive charge appearing at that time was due to the β rays of radium C, the β rays passing through the rubber more easily than the α rays.

In the second series of experiments, a wire was made radioactive as before, and placed inside of and coaxial with a metal tube, the diameter of which was very slightly greater than that of the wire. The metal tube was made air-tight, and the air within it rapidly exhausted to a pressure of about one tenth of a millimeter of mercury. The wire being connected to the electrometer, and the tube to earth, the deflections of the electrometer indicated a continual accumulation of a positive charge from the very start. A series of careful measurements were made of the rate of discharge of negative electricity from the wire at different instants of time after the wire had been taken out of the emanation. These measurements showed plainly that the rate of discharge of negative electricity was not proportional to the ordinary ionization effect of the induced activity; that is, was not proportional to the quantity of radium A and C present on the wire. The curves, representing the decay of the rate of emission of electricity, are much steeper than those representing the rate of decay of the ionization currents, except for the first ten minutes. They agree, approximately, with the theoretical curves, given by Rutherford, representing the sum of the quantities of radium B and radium C on the wire. From this we may conclude that radium B, which hitherto has been considered non-radioactive, emits, approximately, as much negative electricity as does radium C.

If the tube and wire are placed in a magnetic field, so that the lines of force of the field are parallel to the axis of the tube, the rate of emission of electricity is considerably decreased. Further, an electromotive force of a few volts will stop a portion of the discharge of electricity. From these two experiments, it appears, using the usual formulas, that the ratio of the charge to the mass of the carriers of this negative electricity is, at least roughly, equal to that of the β rays. The experiments, however, give only the order of magnitude of this ratio. The velocity, too, of the carriers is very much smaller than that of the β rays, which explains the fact that the rays do not pass through the thin rubber tube, and do not produce a sufficient ionizing effect, to have been discovered by the ionization of gases. The small velocity indicates that the carriers are probably similar to those called by J. J. Thomson δ rays.

A much more detailed account of the experiments will be published as soon as the absolute quantity of electricity emitted by a given quantity of induced activity has been measured.

WILLIAM DUANE.

THE USE OF ASTRONOMICAL TELESCOPES IN DETERMINING THE SPEEDS OF MIGRATING BIRDS.

DURING the spring and fall of 1905 there was developed at the University of Illinois Observatory a method of determining the heights of migrating birds. Two observers watched the moon's disk at night through small telescopes placed some distance apart, and from the different paths seen projected against the moon from the two stations, it was possible to compute the height and direction of flight for each bird. These methods and results are given in papers by Messrs.

Stebbins[1] and Carpenter.[2] It was found that the migrating birds flew much lower than has hitherto been supposed, most of them being less than 1,500 feet from the ground at the time of observation.

The writers of the present article have recently used the same instruments for the purpose of measuring the speeds of migrating birds. The theory of the method is simple enough. Observer F. with a three-inch telescope, was stationed 200 feet south of S., who used a four-inch instrument. On seeing a bird, F. would call 'time' when it left the disk, and S. estimated the interval in seconds until the bird had passed off the moon's edge from his point of view. By drawing a figure it may easily be seen that in the observed interval, the bird had crossed a space not less than the distance between the stations. The lines joining the two observers with the moon were parallel and 200 feet apart, measured horizontally from south to north. From the time required to pass 200 feet, the speed of the bird in miles per hour was derived.

We were successful with this method on only one night during the last migrating season, May 18, 1906. F. at the south station called 'time' for ten different birds, of which three were seen by S. At the signal 'time,' S. would count seconds to himself: 'and, one, and, two, and,' etc., the first 'and' being a half second after 'time,' another half second interval to 'one' and so on. Both of us have had some years' experience in observing transits of stars by the 'eye and ear method,' and we believe these results more accurate than could be obtained with a stop watch.

Two birds crossed the space of 200 feet in one second, and the third in a second and a quarter. The data and results may be summed up in the following table where a correction of 0.2 second has been added to the observed interval to allow for the velocity of sound.

[1] Stebbins, Joel, 'A Method of Determining the Heights of Migrating Birds,' *Popular Astronomy*, **14**, 65, February, 1906.

[2] Carpenter, F. W., 'An Astronomical Determination of the Heights of Birds during Nocturnal Migration,' *The Auk*, **23**, 2, April, 1906.

MAY 11, 1906. WIND S.W., 14 MILES PER HOUR.

Bird	1	2	3
Time of observation	11.30	11.38	11.50
Time to travel 200 ft. (in sec.)	1.0	1.25	1.0
Corrected time	1.2	1.45	1.2
Speed in miles per hour	114	94	114

It should be remembered that these are minimum speeds, for if the birds were not traveling due north they passed over more than 200 feet between observations. From the directions of their projected paths we would conclude that they were actually flying northeast, but we devoted nearly all of our attention to the estimate of times. We consider these results to be correct within ten or fifteen per cent., and, therefore, place the observed minimum speeds between 80 and 130 miles per hour. To obtain the actual motion through the air, these quantities should perhaps be reduced by fourteen miles per hour, the velocity of the wind as shown by an anemometer. The birds were flying nearly with the wind.

To one who has not tried this method, the question at once presents itself: How was it known that both observers saw the same bird? When one has kept his eye fixed at the end of a telescope for five or ten minutes seeing nothing but the moon, and a bird appears within a second after his companion calls 'time,' there is no doubt in his mind that one and the same bird was seen. Moreover, it is possible to show that the path seen by the second observer was in prolongation of that recorded by the first.

It is unfortunate that we did not secure more observations. The observers interchanged places and watched for another half hour, but no more birds were seen from both stations. In all F. saw about thirty-five birds and S. fifteen during the period $11^h 20^m$ to $12^h 20^m$ on the above night. We tried on the two succeeding nights, but there were passing clouds, and apparently fewer birds were flying.

So far as we know this is the first time that two telescopes have been used to determine the speed of birds at night. Professor F. W. Very,[3] working at the Ladd Observatory,

[3] Very, F. W., 'Observations of the Passage of Migrating Birds across the Lunar Disk on the

Providence, R. I., deduced from the time required to pass across the moon's disk, a speed of about 130 miles per hour for some birds. Our results agree closely with his, although the methods are very different. He had to assume the size of the birds in order to compute their distances and speeds, while with two telescopes the results are independent of any assumption as to size or distance. On the other hand, it is possible to secure many more observations with a single instrument than with two, so there are disadvantages in both methods.

With three telescopes it would be possible to measure both the heights and speeds of birds as they fly across the moon. Two observers about ten feet apart in an east-and-west line could obtain data for the heights, while the speeds could be determined by a third observer situated a hundred yards north or south of the others. In short, given a clear night, the moon about full, plenty of birds in flight, and a battery of telescopes, the conditions are perfect for an easy solution of the problem of the heights and speeds of migrating birds; but it will be seldom that all of these requirements are fulfilled at the same time.

JOEL STEBBINS,
EDWARD A. FATH.
UNIVERSITY OF ILLINOIS OBSERVATORY,
May, 1906.

Nights of September 23 and 24, 1896,' SCIENCE, N. S., 6, 409, September 10, 1897.

A WORKABLE BED OF COAL IN NEBRASKA.

ALTHOUGH for years past the state legislature of Nebraska has offered a bounty amounting to four thousand dollars for the discovery of a twenty-six-inch bed of workable coal, and five thousand for a thirty-six-inch bed, it is only within the past few days that any one has filed with the governor legitimate claims for the bounty. The bed of coal recently exposed, near Peru, Neb., extending some forty-two feet along the sides of a tunnel back from the banks of Honey Creek, seems to be fully thirty-four inches in thickness, as measured by the writer. This is known as the Honey Creek or Peru coal mine. The seam is level and readily accessible; the mine, being ten feet above the creek, is easily drained and transportation is at hand. While the extent of the newly discovered bed is a matter of conjecture, the farms near and adjacent to the Peru coal bed are likewise underlaid probably with the same seam of coal, judging from scattered surface indications. It is reasonably certain that a resource of local interest will be developed, and for a time at least Nebraska may lose its distinction 'the state without a mine.' As to the quality of the coal, whether good or bad, matters little, for any coal is good in a state supposed to be destitute of natural fuel. Analyses of the Honey Creek coal made by Mr. L. J. Pepperberg, a fellow in the department of geology in the University of Nebraska are given in the table.

It must be remembered that the following analyses are made from samples which are close to the surface, badly weathered, therefore representing the worst rather than the best of this coal.

	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Total.	B. T. U. per Pound of Coal.	Volatile Matter Per Cent. of Combustible.	Fixed Carbon Per Cent. of Combustible.
Sample No. I., air-dried	10	45.25	36.28	8.47	100	12,621	55.50	44.50
Sample No. II., water-soaked as mined	32.22	28.54	19.38	19.86	100	7,492	54.80	45.20
Sample No. III., lignitic coal, Cumberland, Wyo., for comparison	3.65	44.27	46.18	5.90	100	14,100	54.90	45.10

By the time the tunnel has been extended one hundred feet the overlying shales will be about fifty feet in thickness and the coal will presumably be of better quality. Across the

valley of the Missouri in Iowa a bed of coal, similar in all respects to this one, occurs, and is probably a part of the same bed. The evidence from deep wells at Omaha, Nebraska City, Beatrice and Lincoln, the last named well being 2,463 feet deep, points to beds of coal but a few inches in thickness and thinning rapidly to the westward.

For a number of years coal has been mined in various places in the southeastern, or carboniferous portion of this state, as at Nebraska City, Rulo, South Fork and elsewhere, but the thickness of coal in each case scarcely equaled eighteen inches and there was no profit in mining such coal. The best efforts of a Lincoln company headed by Mr. Bullock, a man of ability and experience, failed to make the mine at Rulo profitable, and the undertaking, like that of others, was abandoned at the end of two years as unprofitable.

Although considerable amounts of coal were furnished at one time by the South Fork Mine to the neighboring towns, Table Rock, Humboldt, Salem, Dawson and Seneca, the bulk of coal mined thus far has been used by those mining it. Farmers and others often dig out their own supply of winter fuel. A vigorous effort was made to develop a bed, said to be eighteen inches thick, in northeastern Nebraska, it being a lignitic coal in the Cretaceous and in no way related to the coal recently discovered. Simultaneously with the discovery of coal at Peru come reports not yet verified of a bed equally thick at Falls City. It has certainly been the opinion of geologists at large that commercial coal was not to be expected in Nebraska, and the occurrence of a workable bed in Peru does not materially change this opinion, for at the best it must be local, as shown by surrounding deep wells. Though limited to a square mile or so it is of importance to this commonwealth.

The owner of the land on which the bed of coal was found leased the mine at the rate of fifty cents on every ton of coal sold for three dollars, and one dollar on every ton sold at four dollars, which may be an item of interest to those regularly engaged in mining.

ERWIN H. BARBOUR.
THE UNIVERSITY OF NEBRASKA, LINCOLN,
April 5, 1906.

THE RELATION OF PRESSURE IN THE CORONARY VESSELS TO THE ACTIVITY OF THE ISOLATED HEART, AND SOME CLOSELY RELATED PROBLEMS.[1]

THE data recorded in this note were obtained in a series of experiments on the excised hearts of turtles, and on the hearts of guinea-pigs, rabbits, cats and dogs, both excised and in situ. The object was to study the effect of various artificial nutrient solutions under different conditions of temperature and pressure with a view of determining their efficiency in restoring cardiac activity. By efficiency is meant the capability of the heart of maintaining an adequate blood pressure.

Defibrinated blood, blood dilutions, Locke's, Ringer's, Howell and Greene's two solutions, 0.9 per cent. sodium chloride, paraffin oil and hydrogen gas were employed.

The animals were etherized and rapidly bled to death, and the blood collected and defibrinated. In isolated preparations, the hearts were rapidly removed and suspended by the base. Cannulæ were inserted and the pericardium removed. Ventricular tracings were made by connecting this portion of the heart to a simple lever which recorded the contractions on a drum. Auricular tracings also were made in some experiments. In all cases of isolated preparations, before the injection was begun, the hearts were bathed in the solutions to be employed. With all the solutions except blood, or blood dilutions, oil and hydrogen, a short series of more or less rhythmical contractions, similar to those evoked by simple mechanical stimulation, promptly followed their application to the heart. In the course of the experiments with the hearts in situ, a constant parallelism was observed between the aortic pressure and the rate of the heart. In order to determine whether this result was

[1] All references to literature have been purposely omitted.

due to intraventricular or to coronary pressure, the heart was excised and the ventricles slit open; injections under pressures varying from 44 mm. to 200 mm. of mercury were then made through the aorta and also directly into the anterior coronary artery. On cessation of the contractions following the external application of the solution to the heart, perfusion through the coronary arteries was begun, and with blood and its mixtures, oil, hydrogen gas, and all solutions, rhythmical beats followed, the magnitude and rate of which varied with the pressure. The evidence seems conclusive that there exists for each solution a certain optimum pressure which produces the maximum rate without a diminution of the amplitude, and that this optimum changes with the condition of the heart. With hearts from the same species of animals, the optimum pressure for each solution may vary widely at corresponding periods of the experiment. The actual change in rate for a given change in pressure may not be constant for different hearts under similar conditions; nor for the same heart under different conditions. The rate may change three hundred per cent. within the limits of the pressure used, variations occurring when the pressure is changed (1) from low to high, or (2) from high to low. Increase in pressure may be considered as a stimulation in the ordinary sense of the term, for the reason that an increase above the optimum causes an increase in rate, and that delirium cordis may be produced if the pressure be raised sufficiently high. If the pressure now be gradually lowered a regular rhythm returns, which becomes slower concomittantly with the fall in pressure. With the same heart, several successive increases and decreases of pressure may cause nearly identical rhythms at corresponding pressures, the gradual increase or decrease of pressure being attended by a fairly constant change in rate for corresponding changes in pressure. A sudden and profound fall in pressure may cause either (1) an immediate increase in rate succeeded by a decrease to the rate previously observed for that pressure, or (2) a slowing of the rate, even to total cessation, succeeded by a return to the rate previously observed for that pressure. The first phenomenon bears some resemblance to that following a sudden fall of blood pressure in the intact animal, *i. e.*, acceleration, and the second bears a striking resemblance to vagus inhibition in the intact heart. In the preliminary experiments with the heart in situ the higher cardiac nerve centers were inactive. When the animal is under light anæsthesia, the changes in rate produced by changing the pressure, both before and after section of the cardiac nerves, are not the same as in the isolated heart, or in the resuscitated heart in situ. The changes in the rhythm are not due to alterations in intraventricular pressure. If, in the turtle, the cannula is introduced directly into the ventricle the beat may be practically stopped, owing, presumably, to distention of the ventricle. Free incision of the ventricles in the excised mammalian heart precluded any distention.

With hearts in situ, and in good condition, following injection of blood dilutions into the aorta, the left ventricle got up a pressure greater than that used for injecting. In no instance were efficient contractions obtained by injecting artificial solutions alone. Their use appears to cause a rapid deterioration of cardiac tissue as regards its susceptibility to restoration and efficiency, though complete loss of irritability may not occur for a long time; *e. g.*, from strips of cats' ventricles bathed in Locke's solution, tracings were taken showing contractions for a period of more than six hours, at which time the experiment was discontinued. Efficient contractions, maintained for relatively long periods, followed the injection of defibrinated blood or blood dilutions. If the perfusion with artificial solutions had not been too prolonged, the hearts could be restored to fairly good condition by perfusion with blood mixtures. The optimum pressure for blood and its dilutions was considerably higher than that for the artificial solutions. This difference may be due in part to a difference in viscosity, but it is also possible that artificial solutions increase the excitability of the preparation by direct action primarily on the vessel walls. Two facts lend some support to this view: (1) bathing

the hearts with artificial solutions is attended by contractions, while blood and its mixtures produce no such effect; and (2) if two strips of cat's ventricle, one cut so as to include a considerable part of the anterior coronary artery, and the other cut from the anterior lateral margin of the right ventricle so as to include no large vessels, be suspended and irrigated with the artificial solutions, the strip containing the coronary artery soon exhibits strong tonus upon which contractions may be superposed, while a little later the other strip begins to contract more or less irregularly and without any change in tonus. It may be observed in this connection that a strip of thoracic aorta may exhibit a deportment similar to that of the ventricular strip containing the coronary artery.

From these observations we conclude that, with hearts under the conditions of our experiments: (1) It is highly improbable that the production of a rhythmical beat is dependent solely upon the constituents of any one of the artificial solutions employed; that these solutions alone are not sufficient to initiate or sustain efficient beats of the heart. It has been shown in this and other laboratories that such solutions are inadequate to restore or even to sustain the activities of the reflex nervous centers of mammals. We have found the addition of a certain amount of blood necessary to render these solutions efficient. (2) For the production of the efficient rhythmical beat of the isolated heart, pressure or circulation of a suitable medium in the coronary vessels is necessary. Injection of blood or its dilutions into the coronary veins is attended by much the same phenomena as have been recorded for injections into the coronary artery, the principal differences being the somewhat lower optimum pressure and the lower pressure necessary for the production of delirium cordis. The character of the beat may differ somewhat in the two cases. As the pressure in the veins necessary to produce rhythmical beats is in all probability higher than that normally present, the mechanism which initiates the normal rhythmical beat must be sought elsewhere. In further support of this view may be mentioned the fact, as determined by inspection, that, on injecting into the coronary artery, the beat begins before much blood appears in the coronary vein, although the beats are weak before the complete establishment of the coronary circulation. In suitable preparations, in which the rhythm is slow, the coronary artery, or the tissue immediately surrounding it, has been observed to pulsate, and the beat to spread from the coronary vessels over the heart.

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F. H. PIKE.
HULL PHYSIOLOGICAL LABORATORY,
THE UNIVERSITY OF CHICAGO,
May 25, 1906.

NOTES ON ORGANIC CHEMISTRY.

ESTERIFICATION OF TERTIARY AND UNSATURATED ALCOHOLS.

NOT long ago there was given, in this journal, an account of some recent improvements in the methods of preparing esters.[1] Although these are of undoubted value, yet the subject, as a whole, can not be said to be in a very satisfactory state because there are no methods, of general applicability, capable of furnishing a good yield of the esters of tertiary and unsaturated alcohols. The primary cause of the difficulty is the greater sensitiveness of these classes of alcohols, which results in the production from them of other compounds, such as unsaturated hydrocarbons or tarry products, in relatively large quantity. This behavior is further accentuated by the fact that the velocity of their reaction and their equilibrium points are both very low. Whereas, in the case of propyl alcohol, if 46.5 per cent. is esterified in one hour and 66.8 per cent. is esterified before equilibrium is attained, these values become 26.5 and 60.5 per cent., respectively, for secondary propyl alcohol, and for *tertiary*butyl alcohol, 1.5 and 6.6 per cent. The figures speak for themselves and demonstrate how great, relatively, is the opportunity for change to take place in the tertiary alcohol by the action of the high temperature or of the mineral acid or other 'catalyst' that may be present.

[1] SCIENCE, XXIII., 712 (1906).

The Grignard reaction, since its discovery a few years ago, has been extremely productive of valuable results and appears to be capable of rendering service in this case also. An ingenious application of it, described recently by J. Houben,[2] constitutes an important advance towards the solution of the general problem described above. The process consists of the following stages: Magnesium, an alkyl haloid and absolute ether are allowed to react in the ordinary manner, to give the Grignard reagent; if ethyl chloride is employed the action may be represented by the equation: $Mg + C_2H_5Cl \rightarrow MgClC_2H_5$. The ethylmagnesium chloride is mixed with the alcohol to be experimented with and there results a hydrocarbon and magnesium alkyloxy chloride; with *tertiary*butyl alcohol the reaction would be: $C_2H_5MgCl + (CH_3)_3COH \rightarrow (CH_3)_3COMgCl + C_2H_6$. The ethane, of course, escapes. The last step consists in adding acetic anhydride to the above product, which results in the formation of *tertiary*-butyl acetate and magnesium acetochloride:

$$(CH_3)_3COMg + (CH_3CO)_2O \rightarrow (CH_3)_3COCOCH_3 + CH_3COOMgCl.$$

The preceding method has already led to the synthesis of a variety of acetates of geraniol and of terpin series, such as terpin diacetate; the resulting compounds are closely allied with some of the odoriferous materials of plants, and their further study promises results of importance and value. The method also gives good service in the esterification of phenols.

Benzylmagnesium chloride, $C_6H_5CH_2MgCl$, may be used in place of the ethyl derivative, but curiously enough, the corresponding bromides or iodides can not be employed; with the former the yield is poor and with the latter the reaction is practically inhibited, except in the case of saturated alcohols, for which, however, the bromides are preferable. The results of a more extended investigation of this subject will be awaited with interest.

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JOHNS HOPKINS UNIVERSITY.

[2] *Ber. d. Chem. Ges.*, **39**, 1736 (1906).

RECENT VERTEBRATE PALEONTOLOGY.

Extinct Mammals of Patagonia.—The third part of the first volume of the *Annales de Paléontologie* under the direction of Dr. Marcellin Boule, professor of paleontology in the Museum of Natural History of Paris, has just been received. It contains the conclusion of Professor Albert Gaudry's review of the fossils of Patagonia, in which this distinguished paleontologist presents the most clear and interesting account of the mammalian life, especially in the Eocene, Oligocene and Lower Miocene. Summaries of the geological results obtained by Hatcher, Ortmann, Tournouer, are given, together with a discussion of the environment of the remarkable succession of mammalian life. This is by far the clearest and most interesting presentation we have yet had of the development of this peculiar fauna. The author is a strong believer in the existence of an Antarctic continent; in fact he regards this fauna as the fauna of such a continent. He observes that Patagonia serves to give us a clear idea of its geographical extent by its climate, remarking 'that if Patagonia is not a part of an Antarctic continent its paleontological history is altogether incomprehensible.' It is interesting to contrast this statement with one recently made to the writer by Sir John Murray to the effect that he found no evidence whatever sufficient to convince him even of the existence of such a continent.

Eocene Mammalia of Northern Africa.—By far the most important paleontological event of recent times was the discovery in 1900 of the ancient fauna of the Fayûm. This is the lake province of Egypt, a district occupying a depression in the desert to the west of the Nile Valley opposite Wasta, a small town about fifty-seven miles south of Cairo. From time to time since this discovery Messrs. Beadnell, of the Egyptian Geological Survey; Dames, of Berlin; Stromer, of Munich; Fraas, of Stuttgart, and especially Andrews, of the British Museum of Natural History, have been presenting short contributions to our knowledge of this fauna. We have now received 'A Descriptive Catalogue

of the Tertiary Vertebrata of the Fayûm, Egypt, based on the collection of the Egyptian government in the Geological Museum, Cairo, and on the collection in the British Museum (Natural History), London,' by Charles William Andrews. The volume is a fine quarto of 324 pages, with twenty-six plates, and a large number of text figures, including several restorations. It is no exaggeration to say that it marks a turning point in the history of the mammalia of the world.

First and foremost is the fact that the ancestors of three great orders of mammals, namely, the Hyracoidea, Sirenia and Proboscidea, are definitely carried back to the Upper Eocene, and the birthplace of these orders appears to be firmly established on the great continent of Africa, which was especially distinguished through a very long geological period as a land mass much less affected by submergence than the other continents, and, therefore, a peculiarly favorable theater for the evolution of terrestrial mammals.

Second, the problematical order of Zeuglodontia, aberrant whale-like forms, are definitely carried back to the Middle Eocene and apparently connected firmly with the land-living primitive Carnivores known as Creodonts. This demonstration we owe to a discovery by Professor Eberhard Fraas, of Stuttgart, a fact which is fully set forth in the present work.

Third, we have established here the occurrence of two entirely distinct and extremely aberrant forms of mammals, both of which possibly represent new and distinct orders, namely, *Arsinöitherium* and *Barytherium*. *Arsinöitherium* is now fully known and differs from every other mammal both in its dentition and in the anatomy of the skull, a most remarkable feature of which is a very large and forwardly pointed pair of horns. The limbs are analogous to those of the Proboscidea and Dinocerata.

Fourth, mingled with these aberrant and peculiarly African forms in the Upper Eocene are the only carnivorous types thus far found, namely, the primitive Creodonta, resembling those of France and North America, and suggesting a land connection and mammalian invasion from Europe. Certain of the Artiodactyl Ungulates characteristic of the Upper Eocene of Europe also appear here, namely, the Anthracotheres.

We may, therefore, consider the hypothesis which was advanced more or less fully and independently in 1900 by Osborn, Stehlin and Tullberg, that Africa was a very important center in the evolution of mammalian life firmly established as a fact; further, that Africa contributed the Hyracoidea, the Sirenia and the Proboscidea to the continents of Europe, Asia and in part to North America.

Some confirmation is also found for the hypothesis which dates back to De Blainville, namely, that widely separated as the Sirenia and Proboscidea are to-day, they may have had a community of origin in Lower Eocene times.

Dr. Andrews is also inclined to regard the evidence which he has now brought together as lending additional support to the theory that in late Mesozoic times Africa and South America were still connected by land. He concludes: 'It appears certain that the final separation of the two continents did not take place till Eocene times,' and that there may have been a chain of islands between the northern part of Africa and Brazil which persisted even till the Miocene. This rests on much more slender evidence than the well-established land connection between Patagonia and Australia, but the résumé which the author gives of the anomalies of distribution which would be explained by such a connection is well worth quoting in full (pp. xxvi–xxvii):

On the assumption that this series of events did happen, there is little difficulty in accounting for most of the peculiarities in the distribution of the various groups. Thus, to mention only a few instances, the presence in both continents of the Hystricomorphine rodents, of chelonians of the family Pelomedusidæ, and of the fishes of the family Cichlidæ is at once accounted for. So also is the presence in the Santa Cruz beds of *Necrolestes*, apparently a close ally of the Cape Golden moles, and of the Sparassodonta, which,

after all, seem to be creodonts and not marsupials. Furthermore, light is also thrown on the numerous points of similarity between Struthiones and the Rheæ, especially when it is remembered that a large ratite bird, *Eremopezus*, existed in the Eocene of Africa. As to the ungulates, it seems likely that the separation of the two areas took place when the main divisions were only just beginning to be differentiated, and that groups like the Pyrotheria and the Archæohyracidæ are not ancestral to the Proboscidea and Hyracoidea of the old world, but more probably represent terms of partly parallel series which had a common ancestry on the common land-surface before the separation of the two regions took place. If this were so, we should expect to meet with a general resemblance between the various groups rather than a close similarity of structure, and this, in fact, is what we find. In the case of the occurrence of the primitive sirenian *Prorastomus* in the West Indies, and of the water-snake *Pterosphenus* in the Eocene beds of Alabama, it seems likely that these animals passed either along the southern coast of the Eocene Atlantic or across the bridge of shallow water between the chain of islands above referred to as probably lying between West Africa and Brazil.

The work is admirably printed and illustrated, and includes reference to all of the literature; and the author as well as the directors and trustees of the British Museum are greatly to be congratulated.

HENRY F. OSBORN.

THE INTERNATIONAL FISHERY CONGRESS, 1908.

AT the Paris universal exposition of 1900 there was held an international congress of fisheries and pisciculture, a permanent committee on international fishery congresses was formed, and plans were laid for holding such congresses regularly in various countries. The first congress was under the presidency of Professor Edmond Perrier, director of the National Museum of Natural History in Paris. The second congress met in St. Petersburg in 1902, under the presidency of Hon. Vladimir Weschniakow, secretary of state and president of the Russian Imperial Fishery Society. The last congress convened at Vienna in 1905 and was presided over by Professor Dr. Franz Steindachner, director of the Imperial Museum of Natural History in Vienna. I attended that congress as the representative of the United States, and extended an official invitation to hold the next meeting in America in 1908, the invitation being unanimously accepted. The place of meeting is Washington, D. C., and the time is September 22 to 26 inclusive. It is a source of gratification to announce that the president of the next congress is Dr. Hermon C. Bumpus, director of the American Museum of Natural History.

In connection with the congress there have been arranged a number of competitive awards for the best or most important investigations, discoveries, inventions, etc., relative to fisheries, aquiculture, ichthyology, fish pathology and related subjects during the years 1906, 1907 and 1908. The awards will be in the form of money; and, although the individual amounts are not large, it is hoped that the conferring of the awards by so representative a body will induce many persons to compete and will result in much benefit to the fisheries and fish culture. The following awards have thus far been provided, and others may be announced later:

By the American Fisheries Society: For a paper embodying the most important original observations and investigations regarding the cause, treatment and prevention of a disease affecting a species of fish under cultivation. $100.

By the American Museum of Natural History: For an original paper describing and illustrating by specimens the best method of preparing fish for museum and exhibition purposes. $100.

By Forest and Stream: For the best paper giving description, history and methods of administration of a water, or waters, stocked and preserved as a commercial enterprise, in which angling is open to the public on payment of a fee. $50.

By the Museum of the Brooklyn Institute of Arts and Sciences: For the best paper setting forth a plan for an educational exhibit of fishes, the species and specimens that should be shown, the method of arrangement, and suggestions for making such an exhibit instructive and attractive. $100.

By the New York Aquarium: For an exposition of the best methods of combating fungus disease in fishes in captivity. $150.

By the New York Botanical Garden: For the best essay on any interrelation between marine plants and animals. $100.

By the Smithsonian Institution: For the best essay or treatise on 'International regulations of the fisheries on the high seas, their history, objects and results.' $200.

By the Fisheries Company, New York City: For the best essay treating of the effects of fishing on the abundance and movements of surface-schooling fishes, particularly the menhaden and similar species, and the influence of such fishing on the fishes which may prey on such species. $250.

By the United States Bureau of Fisheries: For a report describing the most useful new and original principle, method or apparatus to be employed in fish culture or in transporting live fishes (competition not open to employees of the bureau). $200.

By the Wolverine Fish Company, Detroit, Michigan: For the best plan to promote the whitefish production of the Great Lakes. $100.

By Mr. Hayes Bigelow, Brattleboro, Vermont, member of the American Fisheries Society: For the best demonstration, based on original investigations and experiments, of the commercial possibilities of growing sponges from eggs or cuttings. $100.

By Hon. George M. Bowers, United States Commissioner of Fisheries: For the best demonstration of the efficacy of artificial propagation as applied to marine fishes. $100.

By Dr. H. C. Bumpus: For an original and practical method of lobster culture. $100.

By Mr. John K. Cheney, Tarpon Springs, Florida, member of the American Fisheries Society: For the best presentation treating of the methods of the world's sponge fisheries, the influence of such methods on the supply of sponges, and the most effective means of conserving the sponge grounds. $100.

By Professor Theodore Gill, Smithsonian Institution: For the best methods of observing the habits and recording the life histories of fishes, with an illustrative example. $100.

By Dr. F. M. Johnson, Boston, Mass., member of the American Fisheries Society: For the best demonstration of the comparative value of different kinds of foods for use in rearing young salmonoids, taking into consideration cheapness, availability and potentiality. $150.

By the New York Academy of Sciences: For that contribution presented at the congress and not provided for in the foregoing awards which is adjudged to be of the greatest practical importance to the fisheries or to fish-culture. $100.

Further information concerning this matter will be furnished on application to the undersigned general secretary.

H. M. Smith.

U. S. Bureau of Fisheries,
Washington, D. C.

THE PROCEEDINGS OF THE ROYAL SOCIETY OF LONDON.

Of the *Proceedings* of the Royal Society of London, as divided about a year ago into two series, Vols. 76–77 of series 'A,' containing papers of a mathematical and physical character, and Vols. 76–77 of series 'B,' containing papers of a biological character, have now appeared, each running to about 600 pages royal octavo, with illustrations. A main object of this new arrangement was to render the proceedings more accessible to workers by placing the two groups of subjects on sale separately, at a stated price attached to each separate part of a volume when it first appears. Moreover, with a view to promoting the circulation of the complete series, it has been directed that a subscription paid in advance to the publishers at the reduced price of 15s. per volume for either series, shall entitle subscribers to receive the parts as soon as published, or else the volumes when completed, in boards or in paper covers, as they may prefer.

With a view to further increasing the accessibility of the various publications of the Royal Society, each number of proceedings now contains an announcement on the cover, of the more recent memoirs of the Philosophical Transactions as published separately in wrappers and the prices at which they can be obtained.

It is hoped that by this arrangement the difficulties which have been found to impede the prompt circulation of the journals of the society, which are of necessity published in a somewhat different manner from a regular periodical, may be finally removed.

THE AGRICULTURAL APPROPRIATION BILL.

The agricultural appropriation bill for the fiscal year ending June 30, 1907, as finally

passed by the recent session of congress carries an appropriation of $9,932,940. Of this amount the sums appropriated for what may be termed work in applied science are distributed as follows:

The Bureau of Animal Industry receives $4,029,460, but of this amount $3,000,000 are to be devoted to the meat inspection, the discussion of which has occupied so much of the time of congress and of the public press during the past few weeks; Weather Bureau, $1,439,240; Bureau of Plant Industry, $1,024,740; Forest Service, $1,017,500; Agricultural Experiment Stations, including the Department Office of Experiment Stations, $974,860; Bureau of Entomology, $262,100; Division of Publications, $248,520; Bureau of Soils, $221,460; Bureau of Statistics, $210,560; Bureau of Chemistry, $174,180; Office of Public Roads, $70,000; Bureau of Biological Survey, $52,000; Library, $25,880.

The growth of this great government department has been marvelous during the past decade, and the value of its administration to the country at large seems, by results, to have justified this increase in its appropriations.

CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING.

The following list of forty-six institutions is announced by the executive committee of the Carnegie Foundation for the Advancement of Teaching as a first provisional list of colleges and universities admitted to the benefits of the Carnegie Foundation for the Advancement of Teaching.

To professors in these institutions the privileges of the retiring allowances are extended, under the rules of the foundation, as a regular part of the academic compensation and through their own institutions. That is to say, the professors in these institutions receive the allowances which their services earn, immediately upon the request of their institution, as a matter of right.

From this list are omitted all institutions having formal denominational connections, or which require their trustees or officers to belong to a specified denomination. A number of these institutions may in time make clear to the trustees their right to a place in the list.

Similarly are omitted all institutions controlled and supported by a state, province or municipality. The question of the admission of such institutions to the benefits of the Carnegie Foundation will be decided at a meeting of the trustees in November, at which time the representatives of state institutions will have a full opportunity to present any statement they may desire.

All institutions are omitted from this list which fall below the academic standard of a college which the trustees have adopted. Many of these will in time be able to claim places in the list of accepted institutions by raising their standards of entrance or of work. To all three of these classes of institutions there can be no hardship in such delay as may be necessary to enable the trustees to deal thoroughly and fairly with the questions of educational standard and of denominational and state control.

It is not to be understood that the institutions named below are the only ones in which teachers will be granted retiring allowances even at the present time, but to professors in institutions not on the accepted list retiring allowances thus voted will be individual grants in recognition of unusual or distinguished service as a teacher. The trustees have sought to recognize in a generous way individual scholars and the list of those to whom retiring allowances have already been voted includes a number of the most eminent names among American teachers.

The Carnegie Foundation does not give out an official list of those to whom retiring allowances have been granted, but among those whose names have been published in the daily papers are the following: Henry Pickering Bowditch, professor of physiology at Harvard University; George Trumbull Ladd, professor of philosophy at Yale University; Francis A. March, professor of English and comparative philology at Lafayette College; Edward W. Morley, professor of chemistry at Western Reserve University; John Krom Rees, professor of astronomy at Columbia University; Charles Augustus Young, professor of astronomy at Princeton University.

INSTITUTIONS IN THE UNITED STATES.

Amherst College, Amherst, Mass.
Beloit College, Beloit, Wisconsin.
Carleton College, Northfield, Minn.
Case School of Applied Science, Cleveland, Ohio.
Clark University, Worcester, Mass.
Clarkson School of Technology, Potsdam, N. Y.
Colorado College, Colorado Springs, Colo.
Columbia University, New York City.
Cornell University, Ithaca, N. Y.
Dartmouth College, Hanover, N. H.
George Washington Univ., Washington, D. C.
Hamilton College, Clinton, N. Y.
Harvard University, Cambridge, Mass.
Hobart College, Geneva, N. Y.
Johns Hopkins University, Baltimore, Md.
Knox College, Galesburg, Ill.
Iowa College, Grinnell, Iowa.
Lawrence University, Appleton, Wis.
Lehigh University, S. Bethlehem, Pa.
Leland Stanford Univ., Stanford Univ., Cal.
Marietta College, Marietta, Ohio.
Mass. Inst. Tech., Boston, Mass.
Middlebury College, Middlebury, Vt.
Mt. Holyoke College, S. Hadley, Mass.
New York University, New York City.
Oberlin College, Oberlin, Ohio.
Polytechnic Institute, Brooklyn, N. Y.
Princeton University, Princeton, N. J.
Radcliffe College, Cambridge, Mass.
Ripon College, Ripon, Wisconsin.
Smith College, Northampton, Mass.
Stevens Institute Technology,[1] Hoboken, N. J.
Trinity College, Hartford, Conn.
Tulane University,[1] New Orleans, La.
Union College, Schenectady, N. Y.
University of Pennsylvania, Philadelphia, Pa.
University of Vermont, Burlington, Vt.
Vassar College, Poughkeepsie, N. Y.
Wabash College, Crawfordsville, Ind.
Washington University, St. Louis, Mo.
Wellesley College, Wellesley, Mass.
Wells College, Aurora, N. Y.
Western Reserve University, Cleveland, Ohio.
Williams College, Williamstown, Mass.
Western Univ. of Penn., Pittsburg, Pa.
Yale University, New Haven, Conn.

INSTITUTIONS IN CANADA.

Dalhousie University, Halifax, N. S.
McGill University, Montreal, Canada.

[1] On the basis of entrance requirements of 1907.

SCIENTIFIC NOTES AND NEWS.

Dr. Ernst Mach, of Vienna, has been awarded the Bavarian Maximilian order for science and art.

Oxford University conferred, on June 20, the honorary degree of doctor of science on Dr. John Milne, F.R.S., known for his researches in seismology.

The Technical Institute of Berlin has conferred on Mr. George Westinghouse the degree of doctor of engineering.

The University of Vermont has conferred the degree of doctor of science on Mr. C. G. Pringle, keeper of the herbarium of the university.

Dr. William W. Keen, professor of surgery in the Jefferson Medical College, Philadelphia, has been elected a trustee of Vassar College to fill the vacancy caused by the death of Dr. Edward Lathrop.

M. Charles Trépied, director of the Astronomical Observatory of Algiers, has been elected a corresponding member of the Paris Academy of Sciences.

Dr. E. Ludwig, professor of medical chemistry in the University of Vienna, has been elected an active member, and Dr. J. Herzig, professor of chemistry, a corresponding member, of the Vienna Academy of Sciences.

Dr. Cannizzaro, professor of chemistry at Rome, and director Dr. H. Th. Böttinger, of Elberfeld, have been elected honorary members of the German Bunsen Society.

Dr. G. Kraatz, the Berlin entomologist, has celebrated the fiftieth anniversary of his doctorate.

Dr. T. P. Anderson Stuart has been elected president of the Royal Society of New South Wales.

The international celebration of the Coal-Tar Color Jubilee will be held on July 26 and 27. There will be a meeting at the Royal Institution at 11 o'clock on July 26 for the presentation to Dr. Perkin of the portrait, bust and addresses, and there will be a banquet at the Whitehall Rooms at 7 o'clock, at which many distinguished guests are expected to be present. On July 27 a visit will be paid

to the original works at Greenford-green where mauve was first manufactured, and there will be a garden party at Dr. Perkin's house. At 8:30 there will be a *soirée* at the Leathersellers' Hall, at the invitation of Dr. and Mrs. Perkin. The subscriptions to the memorial fund already received amount to over £2,000. Dr. Perkin was elected an honorary member of the American Chemical Society at the Ithaca meeting.

Dr. D. E. Salmon, from 1884 to 1905 chief of the Bureau of Animal Industry, has accepted the offer of the government of Uruguay to organize a Bureau of Animal Industry for that country. Dr. Salmon, who is at present engaged in scientific work in Montana, will start for South America about December 1.

According to a press despatch from Washington, Secretary Wilson, of the Department of Agriculture, has decided not to enter upon his annual vacation until he has completed the organization necessary to put into operation the new meat inspection law. He will give practically his entire time to this work for the next two months. The new pure food law also will require attention, but he intends to leave this almost wholly to Dr. H. W. Wiley, chief of the Bureau of Chemistry.

Sir Frederick Nicholson is at present in the United States in order to study our fisheries on behalf of the government of India.

We learn from *Nature* that Sir Daniel Morris, K.C.M.G., the British commissioner of agriculture for the West Indies, has arrived in England on a short visit, and will attend the forthcoming International Conference on Hybridization and Plant Breeding to be held in London under the auspices of the Royal Horticultural Society at the end of July.

W. J. Morse, assistant professor of bacteriology at the University of Vermont, has accepted the position of state botanist at the Maine experiment station in Orono.

Mr. W. J. Mead, of Plymouth, Wis., has been awarded the Science Club medal at the University of Wisconsin for the best baccalaureate thesis on a scientific subject. His thesis was on 'The redistribution of elements involved in the formation of sedimentary rocks.' The Science Club medal is of bronze, and has been executed by Mr. T. Moring, London.

Mr. E. Maschke, of the geological department of Göttingen University, is desirous of obtaining fossil cephalopods, from all formations, especially from the paleozoic of North America. He wishes to exchange or to purchase them, offering in exchange German fossils and minerals. Secondarily, he wishes to obtain crinoids and trilobites.

Dr. Henry A. Ward, president of Ward's Natural History Establishment at Rochester, N. Y., was killed by an automobile on July 4. He was born at Rochester in 1834, and, after studying at Williams College and Rochester University, became an assistant of Louis Agassiz. From 1860 to 1865 he was professor of natural sciences at Rochester University. Dr. Ward's establishment rendered an important service to science by supplying specimens to museums and other institutions, and in it were engaged a number of assistants who subsequently became eminent men of science.

Dr. Fritz Schaudinn, recently appointed head of the parasitological department of the Institute for Tropical Diseases of Hamburg and well known for his work on the protozoa, died on June 22 from septic infection at the age of thirty-six years.

The deaths are announced of Dr. Ludwig Brakebusch, professor of geology at Hanover, at the age of fifty-seven years; of Dr. Ledebur, professor of metallurgy at the School of Mines at Freiburg, at the age of sixty-nine years; of Dr. Robert Craik, for many years professor of hygiene and dean of the medical faculty of McGill University, on June 28, at the age of seventy-seven years, and of Dr. William Ramsden, lecturer on sanitary chemistry at Manchester University, on June 29, at the age of 29 years.

Sir John Brunner, M.P., has given £5,000 towards the completion and equipment of the additional buildings for engineering, metrology and metallurgy now in course of erection at the National Physical Laboratory, Teddington.

A national dairy congress is to be held at The Hague, in 1907. Among the subjects to be discussed are unification of chemical methods for the examination of milk, butter and cheese, and of milk, butter and cheese control, etc.

Nature states that a banquet was given by the Institution of Electrical Engineers on June 25 in honor of the delegates from kindred institutions in Canada, France, Germany, Italy, Switzerland and the United States who were visiting England. Mr. John Gavey, C.B., president of the institution, presided, and there were about 450 guests and delegates present. The toast of the visiting delegates, proposed by the president, was responded to by Professor J. L. Farny, representing the Association Suisse des Électriciens; Mr. P. J. B. E. Auzépy, consul-general of France; Professor E. Budde, president, Verband Deutscher Elektrotechniker; Dr. Emil Naglo, representing the president of the Elektrotechnischer Verein; Mr. S. S. Wheeler, president of the American Institute of Electrical Engineers; and Mr. Guido Semenza, honorable general secretary of the Associazione Elettrotecnica Italiana, who during his response presented to the institution, in the name of the Associazione Elettrotecnica, a bust of Alessandro Volta. A conversazione in honor of the visitors was held at the Natural History Museum on the evening of the twenty-sixth.

The third International Conference on Plant Breeding will be held in London, from July 30 to August 3, under the auspices of the Royal Horticultural Society. Conferences on this subject were held in London in 1899 and New York in 1902. The president of the forthcoming conference will be Mr. W. Bateson, F.R.S.

The Royal Institute of Public Health has fitted up a laboratory for the study of parasitology. Dr. Sambon has been appointed director of the parasitological department, and Dr. Giordani and Dr. Bonelli are working with him. Systematic investigations have already been started, and many interesting specimens of parasites can be seen at the laboratory. Attention is in particular being given to parasites conveyed by domestic animals, by cattle and by rats.

We learn from the *Scottish Geographical Journal* that an Oceanographical Museum has been established at Berlin in connection with the Institut für Meereskunde. The formal opening took place on March 5, in the presence of the Emperor and the Prince of Monaco, just five months after the death of Baron von Richthofen, to whose initiative the new museum owes its origin. The museum is divided into four sections: (1) A collection illustrating the imperial navy, containing pictures and models of warships, and specimens of guns, torpedoes, etc.; (2) a popular and historical collection illustrating the progress of navigation, with models of modern and primitive vessels, life-saving apparatus, and so forth; (3) a collection of instruments, etc., used in the study of the ocean and its contents, with numerous models showing the height of the continents and the depth of the ocean, the weight and volume of land and sea, respectively, in relation to those of the whole earth, the amount of salt in the sea, and so forth; (4) a collection illustrating the biology of the ocean and the fisheries, with examples of the products of economic value.

The second International Congress of the Association for the Promotion of Hygiene and Salubrity in Dwellings will be held at Geneva from September 4 to 11. The program of the congress is as follows: A, dwelling houses; B, lodgings and places of assembly; C, movable and temporary dwellings; D, art and decoration in relation to the wholesomeness of houses; E, sanitary administration. The general secretary is M. Albert Waurin, 1 Rue des Moulins, Geneva.

At the meeting of the London Zoological Society, held on June 21, the report of the council for the month of May was read by the secretary (Dr. P. Chalmers Mitchell), in which it was stated that 391 additions had been made to the society's menagerie during that month, of which 169 had been acquired by presentation, 14 by purchase, 25 by birth in the gardens, four received in exchange, and

179 received on deposit. The report further stated that the number of visitors to the society's gardens during the month of May had been 61,692, making the total for the first five months of the year 255,280, or an increase of 33,418 visitors as compared with the corresponding period in 1905.

We learn from *The British Medical Journal* that at the last meeting of the Paris Academy of Sciences, MM. Calmette and Guérin made a communication on a new method of vaccination against tuberculosis, with good hopes of its ultimate applicability to the human subject. From numerous experiments, conducted with another object in view, they found that tubercle bacilli killed by heat or treated by different reagents pass through the intestinal wall with the same ease as living bacilli, and are found in the mesenteric ganglia, and even in the lungs. They therefore experimented to see if young animals (calves and kids), given by the mouth, at an interval of forty-five days, two doses of 5 and 25 centigrams of bacilli, either dead or modified in their vitality and virulence by various methods, could with impunity support a meal of 5 centigrams of fresh bovine tubercle, certainly infective for control animals. They have been able to convince themselves that bovine tubercle bacilli, killed by five minutes' boiling or simply heated for five minutes at 70° C. and ingested in given conditions, protect completely for four months at least against virulent infection by the digestive passages; how long the protection endures is not yet possible to state. Details of the actual experiments will shortly be published, but at the present time MM. Calmette and Guérin have proof that young calves can be vaccinated by simple intestinal absorption of bacilli modified by heat, and that this method of vaccination does not present any kind of danger. The experiments must be repeated in a sufficient number of animals to justify the application of the system to the prophylaxis of bovine tuberculosis. M. Roux, after this communication, announced that he is conducting experiments in collaboration with M. Vallée of Alfort on the same lines as MM. Calmette and Guérin, and that the results obtained agree in a remarkable way with those of the experiments of MM. Calmette and Guérin.

We learn from *Nature* that in the course of an address before the annual meeting of the Linnean Society of New South Wales, held in March 28, Mr. T. Steel, the president, alluded to a proposed method of destroying rabbits by means of an infectious disease, the precise nature of which is not yet disclosed. The idea, it appears, originated in Paris, and since the necessary funds have been subscribed by stock-owners and agriculturists it is proposed to commence the experiment on a small island selected for the purpose. After discussing the arguments for and against the proposal, the president considered it highly undesirable that any such disease should be wilfully communicated to any species of animal, by means of which it might be disseminated throughout the country. As to the extermination of the rabbit, that is considered an impossible contingency; but means ought, and can, be found to keep the species in check without recourse to infectious diseases, which may be a danger to the community. In the course of the same address Mr. Steel alluded to the necessity of special efforts if the native Australian fauna and flora are to be saved from destruction. Poison spread for rabbits is responsible for the destruction of a large number of indigenous mammals and birds.

According to the report in the London *Times* Mr. C. B. Marlay presided on June 22 at a meeting of the Royal Botanic Society, held in the museum of the society. Mr. J. S. Rubinstein protested against the system of reelecting members of the council as a matter of course; it was the result of that system that the society was in so unsatisfactory a state. The management of the society was deplorable, and he instanced the inadequate way in which its fête had been advertised. There ought, he urged, to be a properly qualified superintendent of the gardens. Prebendary Barker also spoke. He said that the chairman had not kept his promise, made at the last meeting, to send an official reply to the report drawn up by the committee ap-

pointed at the meeting held on January 24. The council had not wished the committee to receive the reply. The chairman said there had been a misunderstanding in the matter, as he had not made such promise. After a long discussion, Mr. Pembroke Stephens, K.C., announced that the reply would be sent on condition that it was kept secret until the meeting, and, on the suggestion of Mr. Cecil Raleigh, the meeting was fixed for the following Friday at 4:30, when the council met the committee. The chairman, on being asked whether the fellows were liable for the debts of the society, stated that the question was open to doubt, but he believed that in any case the liability of the individual would not be more than £15. Mr. Cecil Raleigh asked that legal opinion should be taken on the subject; at present the position was so bad that the society could not meet a demand for £500 for debentures, which had for sixteen days been ignored. The situation was precarious and serious, not only for the fellows, but for those who in the future might be elected. The accounts ought to be made up and placed upon the table. The chairman, in reply, said that the money was in the bank to meet the present call, and promised that a financial statement should be presented at the next meeting. Mr. Goodsall stated that but for the action of Prebendary Barker, Mr. Cecil Raleigh and Mr. Rubinstein, the extra guinea subscription would have been passed, and the society's finances put on a satisfactory basis.

UNIVERSITY AND EDUCATIONAL NEWS.

THE extensive and valuable collection of fossils and minerals made by James Hall, for more than fifty years state geologist of New York, has been presented to the University of Chicago by Mr. John D. Rockefeller.

AT the annual meeting of the alumni of Hamilton College, Clinton, N. Y., $20,000 was raised for the completion of New South College. Towards this sum Secretary Root, Chauncey A. Truax and Henry Harper Benedict, of New York, each contributed $3,000.

AT the Johns Hopkins University the following appointments have been made: Joseph C. W. Frazer, Ph.D., now assistant, to be associate in chemistry; Solomon F. Acree, Ph.D., now Johnston scholar, to be associate in chemistry; Edward W. Berry, to be assistant in paleontology; August H. Pfund, Ph.D., to be assistant in physics; Arthur S. Loevenhart, M.D., now associate, to be associate professor of pharmacology and physiological chemistry; William W. Ford, M.D., now associate, to be associate professor of bacteriology and lecturer on hygiene; Max Broedel, now instructor, to be associate professor of art in its relation to medicine; Arthur W. Meyer, M.D., now assistant, to be instructor in anatomy; Robert Retzer, M.D., now assistant, to be instructor in anatomy; George H. Whipple, M.D., now assistant, to be instructor in pathology; J. A. English Eyster, M.D., now assistant, to be instructor in physiology; Ralph Stayner Lillie, Ph.D., Johnston scholar in physiology, and Robert Ervin Coker, Ph.D., Bruce fellow in biology.

THE following appointments have been made at the University of Wisconsin: Seth E. Moody, instructor in analytical chemistry; Dr. Caleb A. Fuller, instructor in bacteriology; A. R. Johnson, assistant in organic chemistry; Charles T. Vorhies, assistant in zoology.

BY the resignation of Professor E. H. Gregory, who has been the head of the department, the chair of anatomy in the Northwestern University Medical School has been recently made vacant. It is likely that this professorship, which embraces embryology and histology, will be filled during the summer.

DR. WILLIAM SHIRLEY BAYLY has resigned his position as instructor in geology at Lehigh University, to accept the position of assistant professor of geology in the University of Illinois.

ON account of the resignation of Professor L. C. Hodson, who has accepted a position in the Iowa State College, the position of associate professor of mining at the University of Kansas is vacant.